Articulations of WikiWork:
Uncovering Valued Work in Wikipedia through Barnstars

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ABSTRACT
Successful online communities have complex cooperative arrangements, articulations of work, and integration practices. They require technical infrastructure to support a broad division of labor. Yet the research literature lacks empirical studies that detail which types of work are valued by participants in an online community. A content analysis of Wikipedia *barnstars* – personalized tokens of appreciation given to participants – reveals a wide range of valued work extending far beyond simple editing to include social support, administrative actions, and types of articulation work. Our analysis develops a theoretical lens for understanding how wiki software supports the creation of articulations of work. We give implications of our results for communities engaged in large-scale collaborations.

Author Keywords
Wikipedia, Articulation Work, Online Community, Commons-based Peer Production, Barnstars

ACM Classification Keywords
H.5.3 Group and Organization Interfaces – Computer-supported cooperative work

INTRODUCTION
Dan is a budding fan of the band The Aquabats. He visits Wikipedia–a collaboratively authored encyclopedia–to learn more. He finds an article, but sees a range of inaccurate and incomplete information. Dan turns to the talk page to find a long running disagreement about band membership. Given all the work that Dan could do, how should he allocate his unique but finite creative effort to improve the article?

Those who wish to contribute often look for ways that leverage their unique skills and abilities. However, it is not always easy to know the type of work that is valued by a community. Some studies indicate that individuals come to know how and what they can contribute through legitimate peripheral participation [9]. Other models suggest that large volunteer efforts allow individuals to uniquely align their individual creative talents with the tasks and resources necessary to make useful contributions [5, 6].

While these approaches all help explain the transition from a community observer to a community editor, there has been little research that characterizes the range of work valued by an online community. Our study elaborates articulation work in mass collaborations through a study of the specific types and distributions of work performed in Wikipedia. Further, we provide evidence that articulation work is both recognized and valued by the community.

We begin by briefly reviewing research on work in online communities. Next, we describe key aspects of Wikipedia to facilitate our analysis. We then explain the *barnstars* that form the basis of our dataset. The main part of the paper consists of a description of the range of work acknowledged in Wikipedia. Our analysis unpacks key relationships between work and the specific articulations of work that are acknowledged by Wikipedians. We close with implications for supporting the range of work we identify and the underlying way in which it appears to be articulated.

CSCW IN ONLINE COMMUNITIES
Understanding the work that online community members perform is critical to helping support it. But getting a view of that work is often difficult. Throughout the years, CSCW researchers have uncovered a number of surprising lessons about work in online communities. Early research of online communities enabled through Email distribution lists illustrated the way in which social tasks intersect with work [31, 18]. These findings pointed to the value that the social and emotional support of community members play in maintaining group function. Usenet presented the opportunity to understand online communities of larger scale. Researchers found a variety of activities that participants undertook, from question answering to FAQ building (see *e.g.* [21, 19]).

A more recent development in CSCW is *peer-based commons production* [5, 6], where geographically dispersed volunteers collaborate asynchronously–sometimes at massive scales–to produce content legally ensured to be freely accessible and modifiable. These communities are oriented toward producing and maintaining a valuable artifact [12], in contrast to interaction-focused communities like Usenet. While many of the activities uncovered in early online communities are still relevant to mass collaborations, the complexity and interdependence of the cooperative arrangements extend the range of work.

Two of the most prominent examples of peer-based commons production are Open Source Software (OSS) and

Wikipedia. These efforts are of growing importance given the wide use of OSS and the rising prominence of Wikipedia as an arbiter of fact and fiction. Writing software is quite different from striving to author a neutral account of human knowledge. Software needs to compile. Moreover, it takes tremendous effort to gain the expertise needed to make successful changes. Two major OSS research foci have emerged as a consequence of these conditions: (1) the coordination practices that enable volunteers distributed through time and space to carry out such a tightly-coupled activity [42, 27, 23] and (2) understanding how individuals move from being peripheral to core participants (*e.g.* [17, 39]). There has been less attention paid to a direct empirical analyses of OSS participants' typical work activities.

A firm understanding of the work being done in these mass collaborations is necessary to better support these and future projects. Without understanding valued work, it would be difficult to build tools that help match Dan with valuable tasks to improve the Aquabats article, or build reputation systems that help the community identify trustworthy individuals accomplishing worthwhile tasks. We take a step forward by examining the wide span of activities undertaken to construct the world's largest, cheapest, and arguably high-quality source of knowledge.

WIKIPEDIA: SOFTWARE AND PRACTICE

Before presenting our study of work in Wikipedia, we must describe features of MediaWiki (the software upon which Wikipedia runs), a variety of Wikipedian practices surrounding its use, and what the research community thus far understands about wiki-work.

Users. A user who makes changes to a page is an *editor*. Editors can modify a page anonymously or though a registered account. Anonymous editors are logged by their IP address and registered editors are logged by their account name. A special group of users–*administrators*–are granted technical privileges to protect, delete or merge pages, and block or ban troublesome users. To become an administrator, a registered editor must be nominated by members of the community who recognize the significance of the editor's contributions and their adherence to Wikipedian principles. Nominees are subject to communal review, where the candidate's contributions are examined and testimonials heard. As of February 2008, there were 1356 administrators.

The MediaWiki software supports an API for automated editing by software agents. Many such *bots* have been created to automate tasks such as tagging pages and correcting common spelling mistakes. Users who want to operate a bot need to obtain permission from the community by demonstrating the bot's utility and safety [14].

Pages and namespaces. Wikipedia pages are organized into *namespaces*. The *main* namespace contains the encyclopedic articles; the *user* namespace contains pages for registered users; the *category* namespace allows the construction of categories; the *template* namespace allows the authoring of parameterizable structures that can be instantiated on other pages; and the *wikipedia* namespace contains a set of policy and guideline pages, task- or topically-organized

Figure 1. Templates come in many forms to serve different purposes. The two non-parameterized templates above, defined in the template namespace, are invoked using the {{POV-section}} and {{Expand}} snippets, respectively.

Figure 2. Barnstar given for programming and supporting Suggest-Bot [14], a software agent that performs intelligent task routing [13].

small-group initiatives (WikiProjects), and process-oriented forums [40, 20].

Every page in Wikipedia has a corresponding talk page devoted to discussion about the respective page. For example, every article has a talk page for coordinating authoring activity and every user page has a talk page where other editors can communicate directly with them.

Every Wikipedia page has an *edit history* that documents all changes made to the page. Each entry consists of the article text, time-stamp of the edit, user name of the editor, and an optional user-supplied edit summary. Editors may *revert* a page to a previous version in its history.

Lists, linking, and templates. MediaWiki provides a number of features that allow editors to filter and organize content. *Recent change* lists allow users to monitor recent editing activity, enabling activities like "vandal hunting" [40]. *Watchlists* allow users to subscribe to change feeds for pages in which they have some interest [9].

Lightweight hyperlinking enables the close association between pages in the same and disparate namespaces. For example, hyperlinking supports self-governance by facilitating the tight loop between Wikipedian policy and editing activity [7]. Hyperlinking also enables the creation of *categories*. Categories are special pages that maintain a bi-directional link relationship. When an editor adds a hyperlink to a category page, the page where the link was added then becomes part of that category. *Templates* are slightly more complex than categories. Templates allow for parametrized presentation of content, such as the infoboxes which summarize the most topically relevant information for articles [41]. In addition, by adding a reference to a template, the article is tagged as part of a class, such as articles in need of work [14]. Figure 1 gives two simple example templates.

Work in Wikipedia. Bryant *et al.* discovered that through legitimate peripheral participation, participants come to understand Wikipedia as a rich community with many possi-

ble roles to take on, rather than simply as an editable resource [9]. Although there has not been a direct study of the work done to construct Wikipedia, we can cobble together a first picture through a survey of prior research on Wikipedia.

Editing goes beyond simple textual addition, modification, and deletion. Editing includes the addition of images and sound [35], classification [40, 41], and, increasingly, work related to source attribution [7]. Bryant *et al.* [9] found that talk pages are the main communication channel, and Viegas *et al.* uncovered the many coordination activities conducted there, such as requests for peer review [37]. In a previous study, we found that editors carry out consensus seeking work on talk pages by interpreting policies in efforts to legitimate their actions [24]. These policies are part of a governance structure which is supported by editors who enforce and author policy [20, 7, 10], participate in formal processes [38], and occupy positions of authority [20].

Our understanding of work in Wikipedia has been greatly informed by the work of Wattenberg *et al.* [40]. Motivated to understand how Wikipedians allocate their time, Wattenberg *et al.* pioneered a simple visualization technique to identify systemic editing patterns, which they applied to administrator edit summaries. They found that administrators' work is often heterogeneous, but that they frequently have a current "focal task." Wattenberg *et al.* divide these focal tasks into two categories: *systemic* tasks (*e.g.* list-based tasks like sorting stubs) and *reactive* tasks (*e.g.* watching for vandalism [36] or welcoming new users [9]). While this tool identifies interesting editing patterns, the technique is most suitable for uncovering repetitive actions.

BARNSTARS: OBSERVATIONS OF WIKIWORK

Barley and Kunda [4] argue that a detailed understanding of work is essential to effectively theorizing it. As they point out, the distributed nature of much computer mediated work presents a challenge for researchers attempting to describe the work in detail because much of the work is difficult to observe. On the other hand, in commons-based peer production, much of the activity is inscribed in the artifact, as well as in the boundary objects that help participants coordinate their activities. Researchers studying OSS have, for example, mined cross-module function calls and the version control records to identify sociotechnical dependencies amongst developers [16]. A number of Wikipedia studies have likewise employed the article edit histories to shed light on sociotechnical practices [36, 37, 24, 40, 7]. These activity traces, however, have not been examined to identify the range of work in which participants engage.

We studied one such activity trace in order to understand the range of valued work in Wikipedia. Specifically, we collected and performed a grounded content analysis of *barnstars*. A barnstar is an image accompanied by a short and often personalized statement of appreciation for the work of another editor. Figure 2 shows a barnstar given for a programming contribution to Wikipedia.

Barnstars were invented for the purpose of allowing individuals to recognize the work of others.[1] Anyone can create,

copy, customize and give out these tokens to any other editor. Givers typically post barnstars to the recipient's user or user talk pages. Barnstars seem to carry relatively high value to receivers given their prominence on user pages. Many users will even move them to a "gallery" of Wikipedia-related achievements. While barnstars usually acknowledge some form of work, they can also serve to salve social slights, recognize overlooked work, encourage new editors, foster competition, or even to antagonize a recipient. The nuances behind giving a barnstar often reflect complex social dynamics, similar to gift-giving in any community [25, 34].

Barnstars provide a unique insight into work because the giver sees and evaluates actions in context. Studying barnstars allows us to comprehend the breadth of editor-observed work that is valued by community members. But using barnstars to understand Wikipedian work has limitations. First, some forms of work are more visible than others. For example, the edit histories are the most accessible way to observe the activities of others. Valuable work, such as edits to deleted pages, contributions on mailing lists, and physical meetups, are not captured in the database. Second, barnstars are not descriptions of the work *practices* underlying the execution of work. Barnstars should therefore be treated as a first link to work practices in Wikipedia.

The majority of barnstars are given and received by experienced editors, thus biasing our results in the direction of work valued by these experienced editors.[2] The bias exists for a number of reasons. First, the giver must be familiar with the practice of awarding barnstars. Second, a giver must *observe* the recipient taking actions which the giver believes to be deserving of commendation. These observations can be contemporaneous with the action or after the fact (by observing edit histories). Third, the giver must be capable of identifying and describing the work that is being recognized. Finally, work can be acknowledged only insofar as the giver perceives its value, which may, for example, come as a result of the giver having performed similar or dependent work.

Barnstars do not "articulate" the work they describe in the way Strauss [32] and others use the term "articulation work". Barnstars are observations of the activities of others, but they do not explicate how tasks are divided, scoped, and recomposed. On the other hand, barnstars – as a practice – are articulations of the work of recognizing the contributions of others. Moreover, templated barnstars, such as the Copy Editor's Barnstar, may reflect and start to reify a role structure that impacts how members articulate work. Our focus, however, is on the work *described* by the barnstars, not on the articulating aspects of barnstar giving or the longitudinal impact barnstars may have on coordinated action.

METHODOLOGY

Our first step was to build a parser to extract barnstars from the user and user talk pages. From the November 2006 English Wikipedia database dump, we extracted 14,573 barnstars given to 4880 unique users. We developed an initial

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[1]See http://en.wikipedia.org/wiki/Wikipedia:Barnstar.

[2]In the coded barnstar dataset we describe later, the median number of edits to mainspace articles for barnstar givers and receivers is 1614 and 1723, respectively, while the median tenure is just over a year for both givers and receivers.

codebook by open coding a random sample of 200 barnstars. We then applied the codebook to a second random sample of 200 barnstars. Through our attempt to systematically code the second barnstar sample, we iteratively refined our codes and agreed upon their application to the barnstars.

We used this codebook to iteratively code a random sample of 2400 barnstars. The barnstars were divided randomly into six bins. Two of the authors independently coded each bin. One coder reviewed the codes and noted discrepencies. Discrepencies were iterated upon until there was consensus. After coding was completed, we performed extensive consistency checking of commonly correlated codes.[3]

The codebook contains three groups of codes: (1) the *scope* of the barnstar, such as whether it points to a specific edit or comments on general contributions to Wikipedia, (2) the *genre* of the barnstar, such as whether it is antagonistic, and (3) the *work* that the barnstar acknowledges.

A barnstar often suggests multiple legitimate codings, either because a particular phrasing calls out multiple dimensions or because the barnstar contains multiple independent statements. We therefore chose to apply multiple codes for every code group instead of force-fitting a dominant code. For example, the following barnstar provides evidence of a prior encounter and serves as a peace offering (*genre*), while acknowledging general administratative actions, committment to the project, and conflict mediation (*work*).[4]

⋆ I, **Vali** award **UII** the Worker's Barnstar for his tireless and endless work on the more demanding Wikipedia tasks as an administrator and finding the time to deal with disputes and arguements (some of which are my fault).

Of our 2400 barnstars, 274 were parsing errors where a piece of text was misidentified as a barnstar. The remaining barnstars recognize the work of 1443 recipients (438 administrators) as observed by 1537 givers (382 administrators). These barnstar givers and receivers have contributed 9.7% and 11.8% of all edits to Wikipedia articles, respectively.

THE RANGE OF ACKNOWLEDGED WIKIWORK

In this paper we focus on the work codes. The work codes are broken into seven categories, each comprised of 4 to 10 dimensions. For example, we distinguish one commonly acknowledged work category called "Administrative" with four work dimensions, including dispute intervention and quality designation. Figure 3 gives the breakdown of applied work codes. In this section, we overview our top-level categories and the type of work that falls into each category.

Editing Work (27.8%). The work necessary to create an encyclopedia naturally involves editing, whether by adding large, well-researched sections or fixing spelling errors. In the examples below, we see acknowledgments for copy editing, general editing, and for contributions to specific articles.

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[3]We do not report an inter-rater reliability (Kappa) score. A score for the initial coding would reflect a known methodological problem with multiple coding schemes with a large codebook (low agreement), while the final score would be 100% (complete agreement). Inter-rater reliability scores are not designed to capture the rigor of an iterated approach.

[4]In the rest of the paper we illustrate barnstars using only their text. We underline hyperlinks and show anonymized usernames in bold.

Editing Work		**852**	**27.8%**
minor	copy-editing	112	13.1%
media	images, audio	75	8.8%
initiative	starting articles, stubs	59	6.9%
major	substantial textual addition to an article	56	6.6%
achievement	shepherding an article to a higher quality level	41	4.8%
classification	categorizing articles, adding templates	35	4.1%
redesign	large-scale refactoring, merging pages	22	2.6%
translation	to or from another language	18	2.1%
attribution	citing sources, removing unsourceable info	18	2.1%
general		416	48.8%
Social and Community Support Actions		**763**	**24.9%**
commitment	to an article, a wiki-project	331	43.4%
teaching	mentorship, question-answering	71	9.3%
leadership	of wikiprojects & other initiatives	44	5.8%
humor and cheer	being funny, cheering others up	43	5.6%
user page design	helping to design another's user page	41	5.4%
rewarding	recognizing the achievements of others	22	2.9%
welcoming	welcoming newcomers	15	2.0%
general		196	25.7%
Border Patrol		**342**	**11.2%**
vandal fighting	reverting damage to unspecified namespace	180	52.6%
deletion	article notability, spam removal	63	18.4%
vandal fighting	reverting damage to user pages	30	8.8%
vandal fighting	reverting damage to articles	29	8.5%
sockpuppets	finding users operating multiple accounts	12	3.5%
legal	copyright violations, fair use rationale	9	2.6%
general		19	5.6%
Administrative		**284**	**9.3%**
privilege granting	helping vet potential administrators	163	57.4%
intervention	formal mediation of user conflicts	35	12.3%
quality designation	determining article status (e.g. Featured)	34	12.0%
technical action	exercise of privileged power	30	10.6%
general		22	7.7%
Collaborative Actions and Disposition		**244**	**8.0%**
disposition	civility, accepting of criticism, keeping cool	82	33.6%
adherence	policy interpretation, integrity	77	31.6%
diplomatic action	conflict mediation, consensus-seeking	28	11.5%
explanation	rationale for an edit, decision, or standard	10	4.1%
general		47	19.3%
Meta-Content Work		**128**	**4.2%**
template	design of applicable templates	39	30.5%
tool programming	design & support of tools (e.g. bots)	36	28.1%
forums / portals	creation & support of help desks	15	11.7%
classification	category creation & organization	13	10.2%
process & policy	policy authoring & process design	10	7.8%
archiving	storing away old discussions	4	3.1%
general		11	8.6%
Undifferentiated Work		**447**	**14.6%**
Total work codes applied		**3060**	**100.0%**

Figure 3. Distribution of applied work codes for the 2272 coded barnstars. Top-level work categories are bolded. Work dimensions within each category are given. The percentages given for each work dimension is with respect to the work category, not all categories. The general coding represents barnstars that clearly fall into a category, but were not specific enough to be able to identify a specific dimension.

⋆ . . . **Mani**, you have contributed a great deal of Estonian articles and done major and useful copyedits in a short time. You are a very productive user and deserve recognition.

⋆ I award you, **Magni**, this Barnstar for keeping on top of this Wikipedia article and for being the "Master Editor". Keep up the fine work!

⋆ For your outstanding contributions to AIDS and HIV, as well as your continuing quest to provide accurate (and properly formatted) references in H5N1. Thank you.

But editing activity goes beyond commonly recognized textual contributions. Specialized forms of content creation are also valued. For example, Wikipedians are recognized for adding media like original photography, graphic designs, and even audio recordings of articles, all of which are important to the development of a rich, accessible encyclopedia.

⋆ Hehe, pardon me for the subject, I didn't want to ruin the surprise :-) This barnstar is for your accurate, tireless and thorough work on SVG images and illustrations. We are proud of how much your contributions add to articles contents, look and reader's experience. Keep up the good work!

Another form of editing work is the categorization of articles. Multiple category links can be inserted into the article markup to facilitate classification. Pages can also be anno-

tated with template instances. Some of these templates result in a special banner when the page is served to the reader (see Figure 1). Other templates may annotate content, such as an unsourced fact, which may be tagged "citation needed."

- ⋆ I **Kari** award **Jormungand** for his persistent effort to tag all Indian cities with the WikiProject Indian cities tag.

Although editing is the primary activity, it accounts for only 27.8% of work acknowledged in our dataset. Researchers should pay attention to more than just article authoring.

Social and Community Support Actions (24.9%). The second largest category is the work necessary to support members and keep the community functioning. This category includes welcoming newcomers, initiating or leading new projects, rewarding individuals who give out barnstars, and general social support. In the examples below we see individuals receiving barnstars for their personal characteristics and willingness to help other Wikipedians. The latter two acknowledge the way some individuals explain or teach the norms and practices within Wikipedia. This socialization work is critical to helping newcomers become effective new Wikipedians and for maintaining the social fabric.

- ⋆ For **Idun** for being such a lovely person to deal with...
- ⋆ For helping someone "(I wonder who...)" out of the pit of doom, reviving their trust in Wikipedia and Wikipedians, and for taking the time and effort to help someone in need (and probably prevent them from hurting Wikipedia and their future on this fantastic site), I award you this barnstar.
- ⋆ I hereby ordain **Andhrimnir** to "The Order of the Smiley", for his dedication in helping newcomers like me. Without people like you, we would be lost. Awarded by **Hermod**.

Taking on leadership positions by creating new initiatives and making sure that those initiatives persist is another facet of social and community support. This notion of leadership is distinct from administrative roles because anyone is able to start and contribute to these projects. The first barnstar below acknowledges WikiProject creation, while the second is awarded for leading task-based initiatives:

- ⋆ I award you this barnstar for your hard work creating and establishing WikiProject Missouri, and also for your work welcoming new users! Good work!
- ⋆ I award **Heimdall** this Original Barnstar for his astonishing, great and remarkably timely work on creating various Wiki Fixup Projects, particularly Neglected articles Wow!

Undifferentiated Work (14.6%). There are some barnstars that are not very specific about the actual work completed. Many such barnstars include references to "Janitorial Services" and "mop and bucket", reflecting a general work ethic of cleaning and maintaining various aspects of Wikipedia.

- ⋆ I, **Gerd**, award you this barnstar for your hard work here at Wikipedia, and to let you know I feel your wiki-stress.
- ⋆ **Gefion** awards this Barnstar to **Frigg** for dedicated hard work with the mop and bucket, making Wikipedia better for everyone.

Many of these barnstars might imply editing work, but it would be categorically unfair to prejudice the editing category over other possibly implicated work categories. We did not try to force-fit any barnstar into a particular category.

Border Patrol (11.4%). Not all content added to articles, nor every participant, is deemed to be legitimate. We term work that engages in evaluating and taking action against deviant users and inappropriate content to be *border patrol*. Some "participants" work against the goals of the community or engage in harmful activity. Such deviant activities include *vandalism* (purposely adding false information, deleting legitimate content, or inserting obscenities [36]), *spam* (advertisements or links to commercial sites), *trolling* (purposely inciting other editors), and *sockpuppetry* (clandestine editing under multiple user names). Detecting and disciplining such behavior constitutes a wide range of punitive work in Wikipedia. The most acknowledged border patrol activity is fighting vandalism by reverting or repairing the damage.

- ⋆ For standing with me this morning to revert all of those AOL vandals hell-bent on causing as much trouble as possible, I award you this barnstar.
- ⋆ Wow, you've beaten me to the punch so many times... For consistently defending Wikipedia's articles from the claws of annoying page-blanking vandals, and significantly lowering my edit count in the process, I award you this really cool thing.
- ⋆ I award you the Working Man's Barnstar for reverting vandalism and tagging pages for cleanup, wikifying or deletion like no one else on Earth. It's the first time I give anyone a barnstar and I'm absolutely sure I'll not regret giving it to such a hard-working editor as you.

Border patrol work also entails determining the *notability* of content, that is, whether some content is important enough to be included in the encyclopedia. In the first example below we see an editor being awarded for deleting articles which are not encyclopedic. Second, we see an individual acknowledged as a role model for saving articles tagged for deletion. This last example also illustrates how leadership, as a social activity, and the activity of border patrol can intersect.

- ⋆ For your hard work in removing thousands of unencyclopedic articles from Wikipedia.
- ⋆ You are being rewarded this barnstar for inspiring others to rescue articles nominated for deletion. I took a leaf out of your book and it looks like I have managed to rescue Laura Hannant from deletion.

Not everyone agrees on what work is valued, however. There are deep disagreements about whether Wikipedia should emphasize being the sum of human knowledge (and keep nearly all content) or encyclopedic (and delete traditionally "unencyclopedic" entries) [20]. The following antagonistic barnstar reflects dismay over the work of another editor. It was "awarded" to the giver of the first barnstar above.

- ⋆ For removing thousands of perfectly decent articles that took a long time to make.

Administrative Actions (9.3%). The barnstars in this category pertain to the actions taken by administrators and acknowledge participation in formal processes. Common processes include Editor Reviews and Featured Article Reviews. The first example below is an acknowledgment of an administrative action taken to protect Wikipedia from vandalism. The subsequent barnstars acknowledge, amongst other work dimensions, participation in a Request for Adminship vote and the Featured Article process.

- ⋆ For blocking vandals, and doing it well, and managing to block a load of Willy sockpuppets. Keep the good work up!
- ⋆ Dear **Idun**, how are you? My candidature for administrator has passed with 88/3/1 votes. I was very surprised myself about the amount of support and touching comments that users left about me. Without you and **Disen** it would not have been as easy. You two are amazing and the coolest coaches ever, and for all your efforts and help I am deeply humbled and grateful. For your effort and work, I hereby award you The Barnstar of Diligence. Please

let me know if you need any help or drop by and comment on how my work is doing. Thank you, with kind regards and three cheers from **Elli**.

★ I hereby award you The Working Man's Barnstar for repeatedly notifying relevant parties during featured article reviews, as it's an oft-forgotten task.

Collaborative Actions and Disposition (8.0%). Collaborative Actions and Disposition is differentiated from Social and Community Support Actions by the direct implication of collaborative activity, such as conflict mediation on talk pages. Although this category points to work activities that involve others, it is important to recognize that the dependencies are not clearly present in the texts of the barnstars. In the examples below we see the acknowledgement of interaction styles that are conducive to collegial interactions, even when the work or situation becomes tense or difficult.

★ It is my honor to award Anonymous Editor this...green cucumber with sunglasses, for being cool when the editing isn't. For always keeping a level head. If you can keep your head when all around you are losing theirs and blaming it on you.

★ I award you the "Working Man's Barnstar" for all your tireless work on users in CAT:RFU (requests for unblock). You exemplify the tact and dedication required to do this over-repetitive task successfully, yet retain the ability to not spark up a tense situation (as RFU's sometimes are) with your dedication to remaining civil and cool under pressure. Cleaning out RFU is not an easy job, and requires good judgement; you exemplify this on nearly every occasion. Kudos to you, , and keep it up! I'm confident that if I'm ever autoblocked, I need not fear, because you're around.

Another aspect of Collaborative Actions and Disposition is the work of helping individuals adhere to the formally stated Wikipedia policies. In most cases this work is acknowledged in a positive way. That is, the individuals who are acknowledged for this type of work are often seen as contributing to the general good rather than as individuals who are engaging in broad police action. The example below illustrates how one individual is acknowledged for the work necessary to help Wikipedia and Wikipedians adhere to norms.

★ For always doing the right thing, and remaining neutral in the face of mud-slinging adversaries (and sticking to policy!), I, **Dagur**, award the Original Barnstar to **Bylgia** for his great work on page protection, on this, the 29th day of December, 2005.

Meta-Content Work (4.2%). The last category is work related to meta-content. Meta-content work includes the acknowledgement of tool creation (programming), creation of templates, creation and management of categories or category tags, and work on formal Wikipedia policies.

★ I hereby bestow the "Military history WikiProject Distinguished Service Award" upon you for your tireless development of automated tools that have been of enormous utility to the project.

★ I award you this fine barnstar for the work you did in improving the Taxobox template by adding conservation status shortcuts. I was thinking of doing that myself, but you beat me to the punch!

★ I, **Borghild**, give you this Working Man's Barnstar for your endless contributions to CfD (Categories for Deletion).

ARTICULATIONS OF WIKIWORK

As we have seen, article production involves many different types of work. Article text must be written and edited, media added, and tables formatted. Articles also need to be categorized and defended from vandalism, obfuscation, and spamming. But such work is not done by isolated individuals. Wikipedians need to collectively decompose, scope, and recompose work tasks to make progress. As Strauss explains, "Since the plurality of tasks making up their totality, as well as the relations of actors to tasks, are not automatically articulated, actors must do that too..." [32, pg. 2].

Early in the history of CSCW, Schmidt and Bannon [28] introduced Strauss' concept of articulation work as a critical intellectual challenge for supporting technically-mediated groups. In the intervening years, CSCW has seen many contributions concerning the role that articulation work plays in enabling effective collaborations [33, 8, 30, 11, 22, 3, 15]. A consistent finding is that articulation work is highly contextualized and often under-appreciated. We also understand it to be highly contextualized in Wikipedia, but find that editors *do* recognize the value of articulation work.

Most of the meta-content work dimensions of our codebook show givers acknowledging the articulation work performed by others. These acknowledgements reveal a particular pattern in the articulation of work– the development of work *classes* and subsequent class *instantiations*. For example, the U.S. Presidential infobox template is a class that defines a schema. This class can be instantiated and parameterized on U.S. presidents' articles. It contains standard fields (like "term of office") as well as formatting to control its appearance. Thus a class articulates the work being done at the site of instantiation. We call this the *class/instance* (C/I) approach to articulating work because of its similarity to object oriented programming. In this section, we extend our analysis and give three examples of the C/I approach: template and category authoring & application, bot programming & execution, and policy authoring & enforcement.

Templates and categories. The clearest example of C/I is in the creation and application of templates. The first example below demonstrates the work of instantiating a template for the purpose of explaining why a user is blocked from editing. The next two barnstars acknowledge the articulation work of template (class) authoring. In the last example, the user is acknowledged for both the meta-work of merging templates and for applying those templates to article pages.

★ I hereby award you this **Defender of the Wiki Barnstar** for your numerous and speedy Template:usernameblocks. Keep up the great work!

★ I award you this barnstar for creating {{**O RLY?**}} which will henceforth be used to annotate all dubious claims on articles like 4chan and YTMND.

★ I award you this barnstar for your outstanding work on the embryology template. Grouping many articles into an easily understood navigation pane ensures that all readers have access to the whole picture.

★ Thanks for all of your recent work in combining {{**tl—Infobox Canadian School**}} into {{**tl—Infobox Education in Canada**}}, as well as going ahead and converting the school articles to use the standard infobox template. Your assistance with the template code – especially in figuring out how to correctly display all those optional fields! – is much appreciated.

A class is an articulation of work – it organizes the work to be performed at each instantiation. An instantiation may also articulate work. For example, the {{**O RLY?**}} template above may be used to flag "dubious" content, signaling to others that work could be done to verify the statement.

The C/I relationship also exists between category creation and category link application. The first two barnstars below acknowledge maintenance work on specific categories. The rest acknowledge the use and application of category links.

- ★ For your effort and your kind comments regarding the preservation of the Wikipedians by politics category, I award you the Outspoken Barnstars!
- ★ For all the work you have done sorting out that mess in Category:Stub, I, **Vanir** award you this "Working Man's Barnstar". Wear it with pride.
- ★ For your work on categorization.
- ★ I give this "Working Man's Barnstar" to **Sol** for his tireless work on stub and category sorting.

Wattenberg *et al.*'s study [40] of systematic activity informs our understanding of how categories organize work. In particular, they identified a type of work practice widespread amongst administrators. *List-based work* involves browsing to a category page and then carrying out some task on each of the pages that link to the category page, often in alphabetical order. They make the observation that categorization of pages "is as much about organizing work as it is about organizing content." This list-based work is one work practice that is enabled through the C/I relationship.

Programming bots. Another case of C/I is the relationship between tool programming and their subsequent execution. The use of bots to perform tasks such as tagging pages or reverting vandalism is illustrative. The programmer encodes an articulation of work in a programming artifact. This artifact is then instantiated to carry out its task, either autonomously or directed by an editor. The barnstars below acknowledge editors that created tools or bots, as well as those that used bots to perform work.

- ★ I, **Aesir**, award **Ran** the Golden WikiAward for the creation of **OrphanBot**, who thanks to it, I was warned of the possible deletion of my uploaded image.
- ★ For creating a program (MWT) which is awesome-ly fast and ... well .... awesome, I award you this "da Vinci Barnstar". I'm a loyal tester now.
- ★ Never in my wildest dreams could I have thought that **I** could ever operate a bot if not for you. Thanks for being so patient with me!!!

Policy environment. One use of the wikipedia namespace is for the collaborative authoring of policies that delimit legitimate encyclopedic content and define acceptable behavior. These policies are often cited, through hyperlinking, during discussions on talk pages as editors struggle to figure out how to proceed when there is a breakdown [24, 7]. Policies do not usually provide hard and fast rules, serving instead as guidelines that are subject to interpretation.

The authoring and citation of policy follows the C/I pattern. A policy is a class, an articulation of communal practices and precedent. Policies are often created or modified when a contributor encounters breakdowns that are not handled adequately by the current policy environment [20, 7]. For example, a group of editors may be deliberating on whether it is legitimate to include a link to a well-respected scientific blog to support a claim in a scientific article. If the Reliable Sources (RS) policy does not cover blog links in articles on a scientific topic, one of the editors may decide to add the outcome of their discussion to the RS policy. If the issue arises

again in another article, those contributors will be informed by precedent. By contributing to a policy, an editor helps to articulate the interpretation work that other editors will perform at the site of a future policy citation. Conversely, an instantiation of policy brings to bear the articulated lessons of the many policy contributors.

The C/I pattern thus organizes and scopes consensus-seeking effort into distinct spaces. Widely pertinent issues can be discussed and collaborated on at the class definition, as we saw with policies. This holds for the other C/I examples. Categories can be refined, merged, deleted, and put into hierarchies, automatically modifying their instantiations. Global changes to how presidential infoboxes are displayed can be done by simply modifying the template definition. The mechanisms that support classes – as articulations – are flexible enough that they can evolve alongside the community.

DISCUSSION AND IMPLICATIONS

In our study, we have presented a view on the span of valued work in Wikipedia and uncovered a pattern in how work is articulated. In this section, we draw out implications for our results. We develop a theoretical perspective on how C/I facilitates effective articulations of work by accounting for social dependencies, consider implications for the reflection of work, and discuss how our methodology may generalize.

Accounting for social dependencies

Wikipedia employs a consensus-based decision-making model [36, 24, 20, 7]. But obtaining consensus from the entire community for each action is untenable. Some work, like blank-vandalism reversion, typically requires little consensus. The systemic and reactive work identified by Wattenberg *et al.* [40] fall into this category.[5] Other work, like shepharding an article to Featured Article status, require an investment in understanding the context and interacting with others before the work can be effectively executed. Work in Wikipedia thus varies widely in its social dependencies.

Wikipedia's normative structure of policies and processes helps define ways to account for social dependencies. We call an action *legitimate* if it is executed in a way that is congruent with Wikipedia's normative structure. An action then has a dependency when appropriate editors must participate in the decision-making process for the action to be legitimate.[6] The term "appropriate editors" is situationally dependent. It might mean that an article's main author needs to be involved, or that a quorum of editors with expertise in deletion procedures needs to assemble. Consider the range of processes formalized to help determine whether an article should be deleted because it lacks "notability." "Speedy delete" defines a case where administrators may delete obviously non-notable entries (like spam) without discussion, "proposed deletion" legitimizes the deletion of a marked article in 5 days if no one objects, and "articles for deletion"

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[5]Chromograms require patterns in the first three letters of the edit summaries. Interdependent activity is unlikely to be so patterned.

[6]We do not mean to imply that editors always need to mediate social dependencies before they act. Rather, mediating social dependencies takes place throughout the course of editing. In fact, Wikipedia has a mantra of "being bold"–make an edit and see if it sticks. This is similar to OSS development work, where the practice is to commit the code first and coordinate later [42].

is an open-ended process which cannot be "closed" legitimately without some demonstration of consensus.

The C/I pattern helps explain how Wikipedians have appropriated wiki technology to account for social dependencies. We look at two cases: templates and policy. Templates can be instantiated to draw attention to an issue that falls into a general class. For example, when an editor instantiates the {{**Speedy Delete**}} template in an article, the corresponding article deletion process is invoked. The editor signals that the decision is relatively obvious and has few social dependencies. Editors that care can monitor instantiations of the class to decide if they want to join the discussion. Templates thus help editors account for social dependencies by: (1) attracting appropriate editors to a given issue, (2) providing a way for editors to pay attention to instantiations of specific work classes that they care about, and (3) facilitating communication about the issue at hand.

The practice of hyperlinking to policy pages also illustrates how the C/I pattern helps editors account for social dependencies. Many Wikipedian policies are oriented toward content, style, and organizational coherency. By hyperlinking to a policy (instantiation), the editor brings to bear on the current discussion a social dependency on past decisions, which were deliberated by the authors of the respective policy page. The relevance of the policy must also be addressed else the editors risk engaging in illegitimate activity [24]. Consider again the case where editors are struggling over whether to include a hyperlink to a blog–an issue addressed by the Reliable Sources guideline. If none of the editors are aware of the guideline, and thus do not account for its precedent, then it is a benign illegitimacy. But if the guideline is hyperlinked to, every editor is provided with a simple means to learn about it. Any blatant dismissal of the dependency is likely deviant. If the editors choose to break with precedent, they must be ready to defend their decision.

A challenge for editors is to recognize the appropriate class that a situation falls into. In the above two cases, the editors had to conclude that the article falls into the purview of {{**Speedy Delete**}} and the the Reliable Sources guideline, respectively. For experienced Wikipedians, this may be routine, but a newcomer is unlikely to know about the various deletion processes or content policies. The burden of classifying a situation, as well as educating newcomers about relevant process and policy, falls on the community.

More can be done to support editors as they work to account for social dependencies. Current tools do not help editors to identify (1) potential classes to instantiate in a given situation and (2) cases throughout the project where a class *should* be instantiated. At root is the problem of categorizing situations according to the classes defined in the community's normative structure. For example, figuring out if a situation is an instance of a particular type of conflict.

There are numerous indicators of social activity that can be mined to help build tools to support situation classing. As editors instantiate and link to classes, they create a corpus of labeled data. Patterns of prior class instantiations can then be used to construct probabilistic models that predict when some new activity is an instance of a previously observed class. For example, a policy citation in a discussion invokes a class and labels the discussion as somehow relevant to the class. A model using commonly co-occurring text surrounding hyperlinks to policies might identify which policies are relevant in a given discussion. A model that uses deletion instances as features might identify the proper deletion process to instantiate. The C/I pattern of organizing work allows system developers to build tools that index the normative structure of the community. Tools that employ such *normative indexing* might help foster coherency across Wikipedia, as rapidly evolving standards and precedent are made more apparent to new and experienced editors alike.

Reflecting work

An important direction for online communities research is to formulate recommendation and reputation mechanisms that help members identify trustworthy partners for interaction, deal with newcomers who do not yet understand community norms, and encourage desirable activity. We consider how both mechanisms are informed by our results.

Recommendation. While templates and categories are one way to draw in editors, other means of attracting editors could help account for social dependencies. Cosley *et al.* proposed a highly relevant method called intelligent task routing (ITR). ITR matches individuals with different tasks in an online community [13]. The work culminated in SuggestBot, a bot for recommending work to Wikipedians [14]. Their algorithm balances the work needs of the community (by mining instantiated templates) with individual interests (a model of topical interest built from article editing activity). Considering the wide variety of non-authoring work that Wikipedians perform, ITR may be enhanced by also accounting for individual interests in the *type of work* to be performed and the social dependencies that the work might have. An editor may be recommended work on a notability discussion on an unfamiliar topic because the editor had been previously recognized for dealing with such issues.

Reputation. Systems that model reputation may impact participants' activities depending on how work is measured and valued by the reputation system. Many reputation models reflect a singular dimension of an individual and thus risk marginalizing work critical to maintaining effective group performance. A case in point is the neglect of social and emotional support [26], which was implicated in 25%-30% of our applied work codes. Our analysis shows that there is a wide range of observable work performed by individuals and that editors do not necessarily agree on what constitutes valuable work. Moreover, the work performed by individuals and the community will change over time. A consequent challenge for system designers is to build reputation mechanisms that are flexible enough to grow with the community and do not enforce a static valuation of the work performed.

A more sophisticated reputation framework would allow editors to *compose* the behavioral and social dimensions of activity as a lens through which they view another editor. With this framework any editor could implement their own understanding of valued activity and the community could collaborate on what constitutes an appropriate composition of

activities for a reputation. What constitutes a good reputation for "vandal fighter" might be different from what makes a good "administrator."

Articulation work, 4% of recognized work in our dataset, is also routinely marginalized in systems that support collaboration. The class/instance pattern facilitates one approach that systems designers could use to explicitly recognize articulation work: reputation could accrue to the authors of classes of work whenever another user instantiates that class. For example, authors of the {{**Speedy Delete**}} template might gain reputation whenever the template is instantiated.

Adler *et al.*'s content-based reputation system is the only implemented reputation system for Wikipedia to date [2]. Reputation is solely a function of the longevity of textual additions to mainspace articles. But the authors are only interested in reputation insofar as it informs a predictive model of textual reliability [1]. The system does not expose individuals' reputation scores. If the Wikipedia community chooses to reveal editors' computed reputations, we strongly encourage the adoption of a reputation model more reflective of the range of valued work.

Gifts & the study of work in mass collaborations

There are many strategies that researchers might use to study work in online communities. Wattenberg *et al.*'s use of Wikipedian editor summaries provide *self-documented* activity profiles. This style of dataset might also be lifted from commit logs for OSS projects. Bryant *et al.* [9] and Forte *et al.* [20] employ *interviews*. Classic *ethnographic* techniques can help gain a glimpse into editors' in situ experiences. The classes that Wikipedians instantiate to signal that a task needs to be performed (*e.g.* "citation needed") could also be used. Cosley *et al.* [14] employed such a *demand-based* dataset, but did not relate it to an understanding of the division of work. Bug repositories in OSS projects also provide a demand-based view of work.

Barnstars are *acknowledgement-based*. They capture the in-situ observations of another editor and are therefore tertiary to work practice. Our categories and the distributions of work as expressed through the systematic coding point at the work of Wikipedia, but the categories themselves do not indicate how the work is done. In the case of the C/I pattern, we are left to infer the actual enacted articulation from the rationalized description of the articulation given in the barnstar. The work described in barnstars therefore provides a basis for researchers to investigate the composite practices that underlie the execution of acknowledged work. Through barnstars and the technical traces of the articulation, we can begin to see something of how articulations happen as a set of actions enabled by a specific collaborative infrastructure. Barnstars show us where to look.

The generality of an acknowledgement-based approach relies on community members recognizing the work of others. The availability of these recognitions hinges on at least three conditions: (1) a persistent communication space, (2) a means to make work visible, and (3) the existence of a gift-giving culture. In an ad-hoc search we were unable to identify work recognitions in online collaborations like Every-

thing2, Distributed Proofreaders, and Wiktionary. We can give two examples where this culture likely exists, though it is only crudely (or implicitly) supported by the software. First, in the Ubuntu Forums there is a "thanks" button associated with each post. Second, in the Perlmonks community, giving someone credit for uncovering bugs or offering suggestions on code postings is evidently a mature norm.

An important area for future research is to study the effects of barnstars on member retention and, more broadly, the mechanisms and conditions under which a gift-giving culture for online mass collaborations might thrive. If there is a demonstrable effect of barnstars, the prevalance of acknowledgement datasets may grow as more communities provide support for gift-giving. But more importantly, the underappreciated social-support work in these communities might be better nurtured. Its hard to believe that there is not some positive effect, considering barnstars like the following:

⋆ Thank you so much for the barnstar! This morning reminded me of Christmas when I woke up and suprisingly discovered a wonderful gift awaiting me. It's so nice to find worthy editors who appreciate the contributions of others and in return I'd like to award you with this barnstar to note your kind and gracious behaviour. Best of luck in the future and Thanks again!

CONCLUSION

To understand and support work, we need empirical investigations into actual work practices [32, 4, 28]. However, despite prominent theoretical and popular accounts of how commons-based peer production is rewriting the rules of organizing [6, 29], there is a notable lack of empirical studies of the work done by members of online communities. In this study, we have made a first attempt to characterize the range of work in one of the more prominent mass collaborations. We have made four main contributions:

- Presented empirical data on the range of acknowledged work in Wikipedia. We found evidence for a wide span of non-authoring work, including social support and the acknowledgment of articulation work.

- Uncovered the class/instance pattern of articulating work. To our knowledge, this is the first study with findings about the articulation of work in mass collaborations.

- Described an acknowledgement-based approach to studying work in online communities.

- Brought out implications of our results, including accounting for social dependencies through normative indexing, reflecting work with a composable reputation framework, and fostering gift-giving communities.

The next step is to trace the actions of barnstar recipients in the publicly available dataset and see how the actions compare with the barnstars they received. But while the scale of the collaborative activity captured in the Wikipedia dataset is immense, it is important to recognize that much more goes into the actual "work" than what is recorded in the database. Intense reading, planning, managing time between other commitments and Wikipedia, checking and responding to watchlists, participating in discussions on mailing lists – these work practices are largely invisible.

Researchers must strive to move past the hegemony of the actions recorded in the database if work is to be understood. Our study provides CSCW researchers seeking to better understand and support mass collaborations a foundation for forming interesting hypotheses, regardless of whether the exercise is content analytic, ethnographic, or systems-building. Researchers looking to understand how large-scale efforts succeed might fruitfully explore the C/I pattern in order to uncover whether and how participants actually go about creating and instantiating work classes.

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